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WHAT TO DO WITH THE SALT: SOLAR EVAPORATORS & SALT AS A RESOURCE

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Salt imported with irrigation water must be controlled and removed to sustain the productivity of land. From the technical point of view, the easiest way would be to dispose of drainage water and salt into the ocean. Farms in the San Joaquin Valley have a great advantage, in comparison with many other world agricultural regions, in their proximity to the ocean. However, ocean disposal invites economic, environmental, and political questions.

The case can be made that responsibly managed ocean disposal would not create any environmental problems. The salt concentration in ocean water is 33,000 mg/L. This represents 3.3 billion t of salt in an arbitrary selected ocean section of 100 km^3 (10 x 10 x 1 km). This is very small portion of the ocean. Adding 1 million t of salt from the San Joaquin Valley to this limited section would increase the salt concentration to only 33,010 mg/L, which is absolutely insignificant.

Ocean disposal requires a significant investment as well as annual operating costs in future years. Experience from handling other waste products clearly indicates that the costs of waste disposal are continuously increasing. That is the reason why many previous waste effluents are being increasingly used as valuable resources. This leads to the vision of using drainage water and salt in a similar way.

The challenge is to manage drainage water and salt on irrigated farmland as resources rather than as waste products. This paper will describe the system concept as well as practical results achieved on two farms in the San Joaquin Valley. Methods of managing drainage water and salt as waste or resources are described in Figure 1.

Some growers and water districts have constructed evaporation ponds for the discharge and evaporation of drainage water, and the salt removal. This is a practical technical solution which, however, has several drawbacks, mainly (1) evaporation ponds require about 10 percent of the area of drained farmland, (2) annual expenditures are required to maintain these ponds, (3) wildlife control may be difficult and expensive due to the large size of ponds, (4) drainage water is wasted instead of being utilized, (5) it is only a temporary solution as the problem of accumulated salt will have to be addressed later, and (6) the system is exposed to complicated and costly regulations.

Technological changes may minimize some regulations or completely eliminate any need for regulations. Technologies can be developed in technically, economically, and environmentally responsible ways. This goal has been a driving force in the development of methods for the sequential reuse of drainage water, solar evaporators, and salt harvesting.

To sustain productive farming on irrigated land, to assure wildlife safety, and to minimize regulations the following tasks need to be achieved:

* remove the salt being imported with irrigation water
* temporary store salt on the smallest possible area of a farm
* use this small storage area for the evaporation of drainage water
* manage this small storage/evaporation area with respect to wildlife safety (birds can be controlled by netting of a small evaporation area or by hazing methods)
* evaporate drainage water in this small area (this requires a reduced volume of water)
* reduce the volume of drainage water by sequentially reusing it for the irrigation of salt tolerant trees and crops
* generate a smaller amount of drainage water through well managed irrigation practices

This concept of salt management has been tested on several farms in the San Joaquin Valley since 1985; and it is practically demonstrated on 640 acres of the Red Rock Ranch near Five Points (Figure 2). Components of this water and salt management system include:

+ several rows of trees on the west side to intercept the subsurface flow of saline water coming from the area west from the field
+ drainage system installed to reclaim 480 acres of the farm and control salinity; this creates conditions for the production of higher value, salt-sensitive crops (vegetables)
+ reuse of drainage water from these 480 acres to irrigate cotton, alfalfa, sugar beets, and other salt-tolerant crops on 120 acres (divided into three 40-acre fields)
+ removal of drainage water and salt from this 120-acre area (move drainage water and salt through these fields)
+ reuse of this drainage water to irrigate salt tolerant trees (13 acres)
+ removal of drainage water and salt from this 13-acre field (move drainage water and salt through this tree area)
+ reuse of drainage water to irrigate halophytes / plants requiring salt (4.6 acres)
+ removal of drainage water and salt from this 4.6-acre field (move drainage water and salt through this field)
+ discharge of reduced volume of drainage water, with a relatively high salt concentration, into a solar evaporator (1.8 acres)

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This water and salt management system is based upon common farming practices:

- irrigation water management
- drainage systems
- reuse of water
- use of trees for water uptake (control of groundwater levels or interception of water flows)
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Two elements have been added to the system:

halophytes as potential commercial crops
a solar evaporator for the evaporation of a small volume of drainage water (with high concentration of salt)

Different types of halophytes have been evaluated as a component in the system for the sequential reuse of drainage water. The potential commercial value of halophytes is for oil, biomass for energy or industrial uses, and forage crops. Feeding trials were conducted with selenium-enriched halophytes as a feed supplement for livestock. The test results clearly indicated the transfer of selenium into the blood system. Samples of halophytes were also given to a company to produce construction materials.

The solar evaporator is a relatively small area covered with a plastic liner. Drainage water is discharged into this evaporator in correlation with daily evaporation rates. Both flooding and sprinkler methods have been tested. Average evaporation values are used to adjust electronic controllers for the automatic operation of water discharge systems. An ET gage will be installed this year. The small area of the solar evaporator is less attractive to wildlife than large evaporation ponds. To further enhance wildlife safety, hazing equipment will be installed this year. Netting of small solar evaporators is also considered. The possibility of commercial production of brine shrimp is also being evaluated. In this case, all drainage water and salt would be productively utilized, and they would be managed as resources. Brine shrimp is the multimillion-dollar industry.

A research and development program has started to develop commercial uses for harvested salt. Preliminary laboratory tests indicate the possibility of using salt in the production of tiles and other construction materials. Investigations in other product areas will also be conducted.

Two projects developed in the San Joaquin Valley have been funded by the Bureau of Reclamation. The final evaluation and reports will be completed in December 1997. The preliminary data indicate that:

1. The required area of solar evaporators is about 40 times smaller than the corresponding area of evaporation ponds. A 1,000-acre farm requires about 100 acres of a evaporation pond, compared to about 2.5 acres for a solar evaporator.

2. About 80 to 85 percent of drainage water is used to produce salt tolerant crops, trees and halophytes. Only about 15 to 20 percent of drainage water is wasted in the evaporation process, not being productively utilized.

3. A long-term salt and boron balance in soils can be achieved through the sequential reuse of drainage water. The comparison of 1987 and 1995 soil data indicate no increase in salt or boron concentrations to the depth of 2.1 m (7 feet).

4. About 350 tons of salt was "moved" through the trees and halophyte areas and deposited in the solar evaporator on one experimental farm in 1997.

5. A significant reduction of selenium and nitrate loads is achieved through this system of sequential drainage water reuse.

Conclusion

The system for the productive use of drainage water and salt harvesting in a solar evaporator works. Its various components need to be matched to achieve the integrated management of water and salt. The result is a well designed salt management system which could be viewed as a "water/salt management puzzle" as well (Figure 3). Future work should be mainly oriented towards the development of salt products and their commercialization, maintaining wildlife safety, increased efficiency of solar evaporators, the introduction of economically viable halophytes, and the development of practical regulatory policies.

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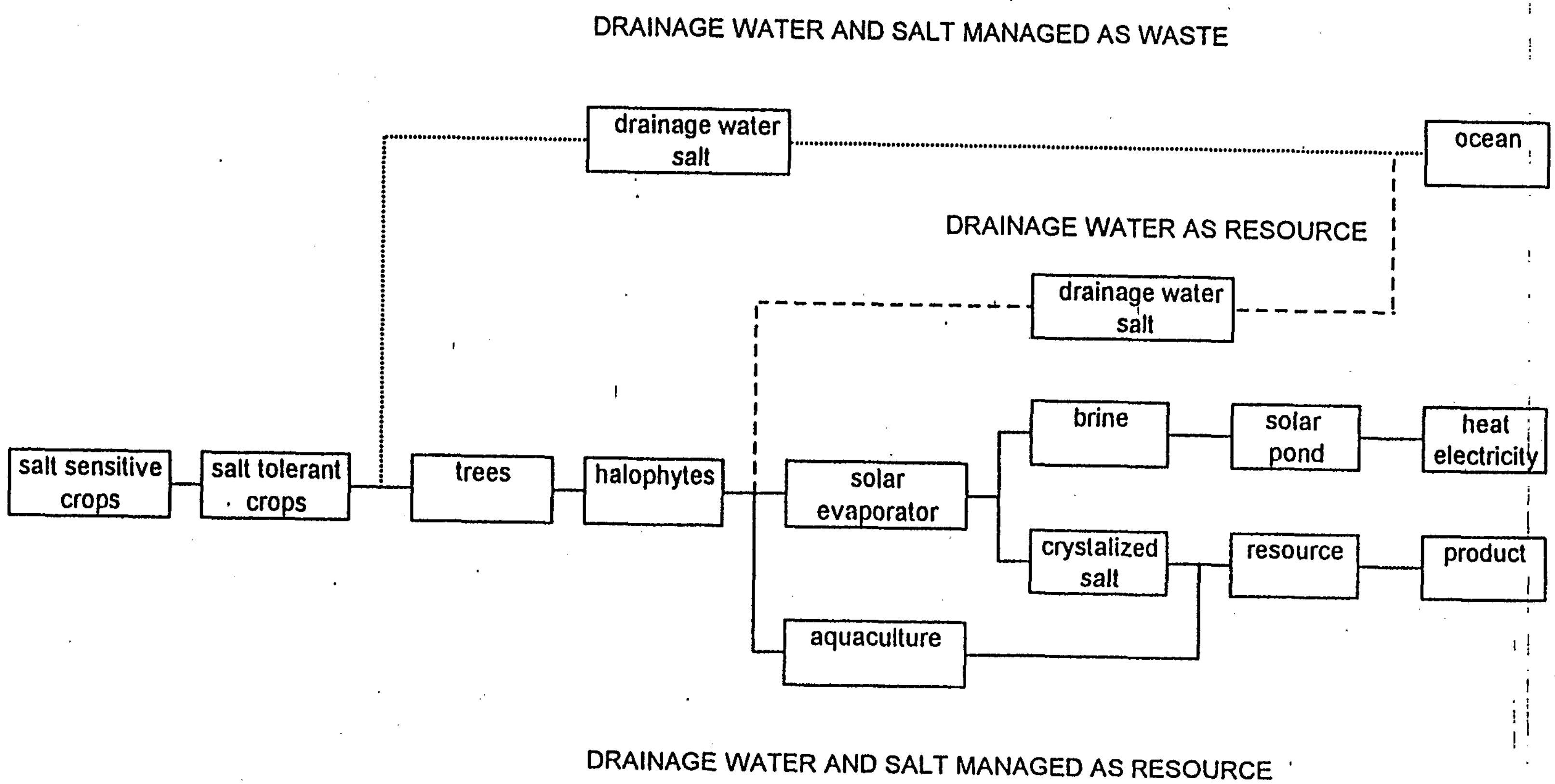
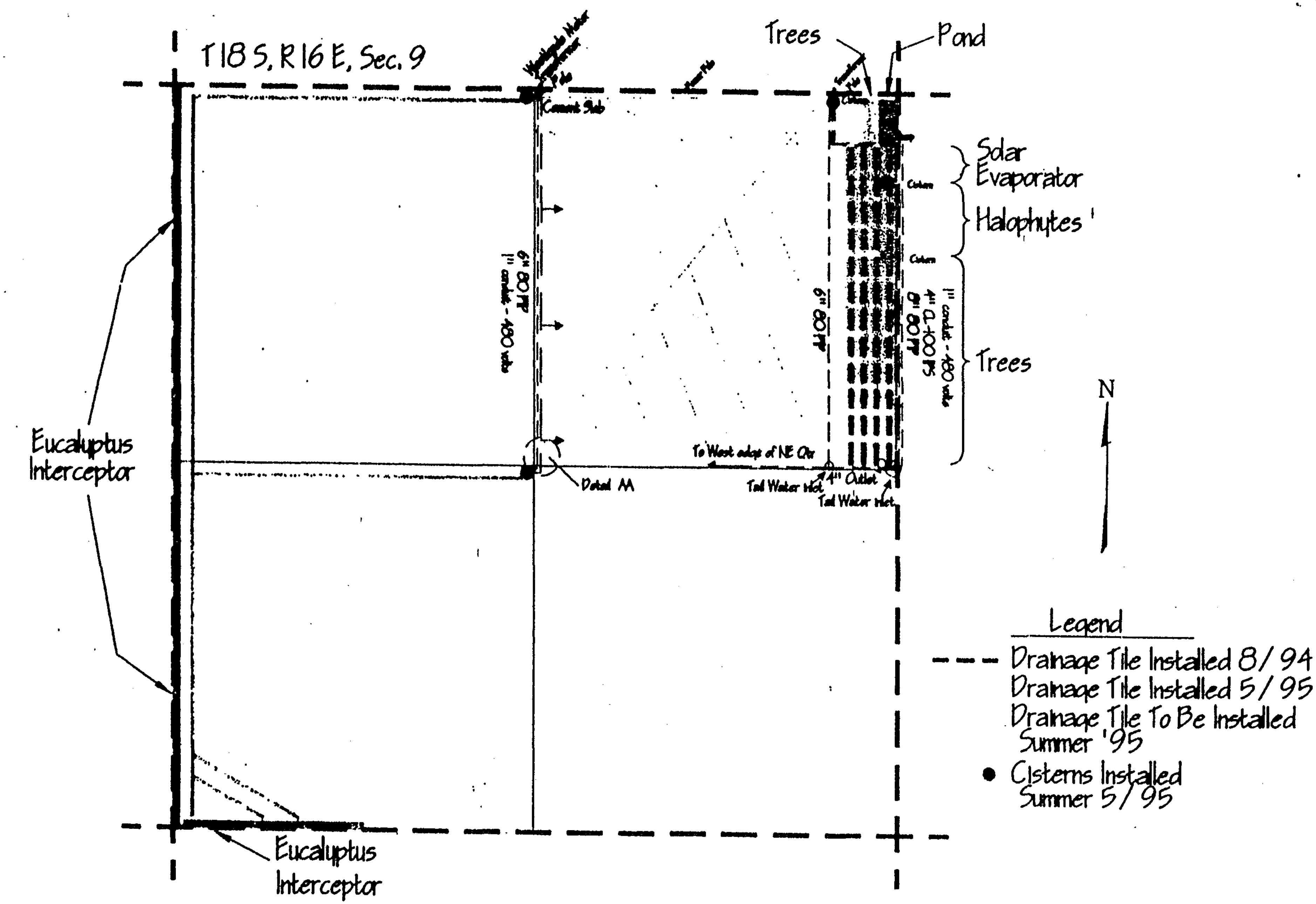

DRAINAGE WATER AND SALT MANAGED AS WASTE
drainage water salt
ocean
DRAINAGE WATER AS RESOURCE
drainage water salt
salt sensitive crops
salt tolerant crops
trees
halophytes
solar evaporator
brine
solar pond
heat electricity
crystalized salt
resource
product
aquaculture
DRAINAGE WATER AND SALT MANAGED AS RESOURCE

Figure 1.



Red Rock Ranch Agroforestry Site
Underground Utilities
Figure 1

Figure 2.

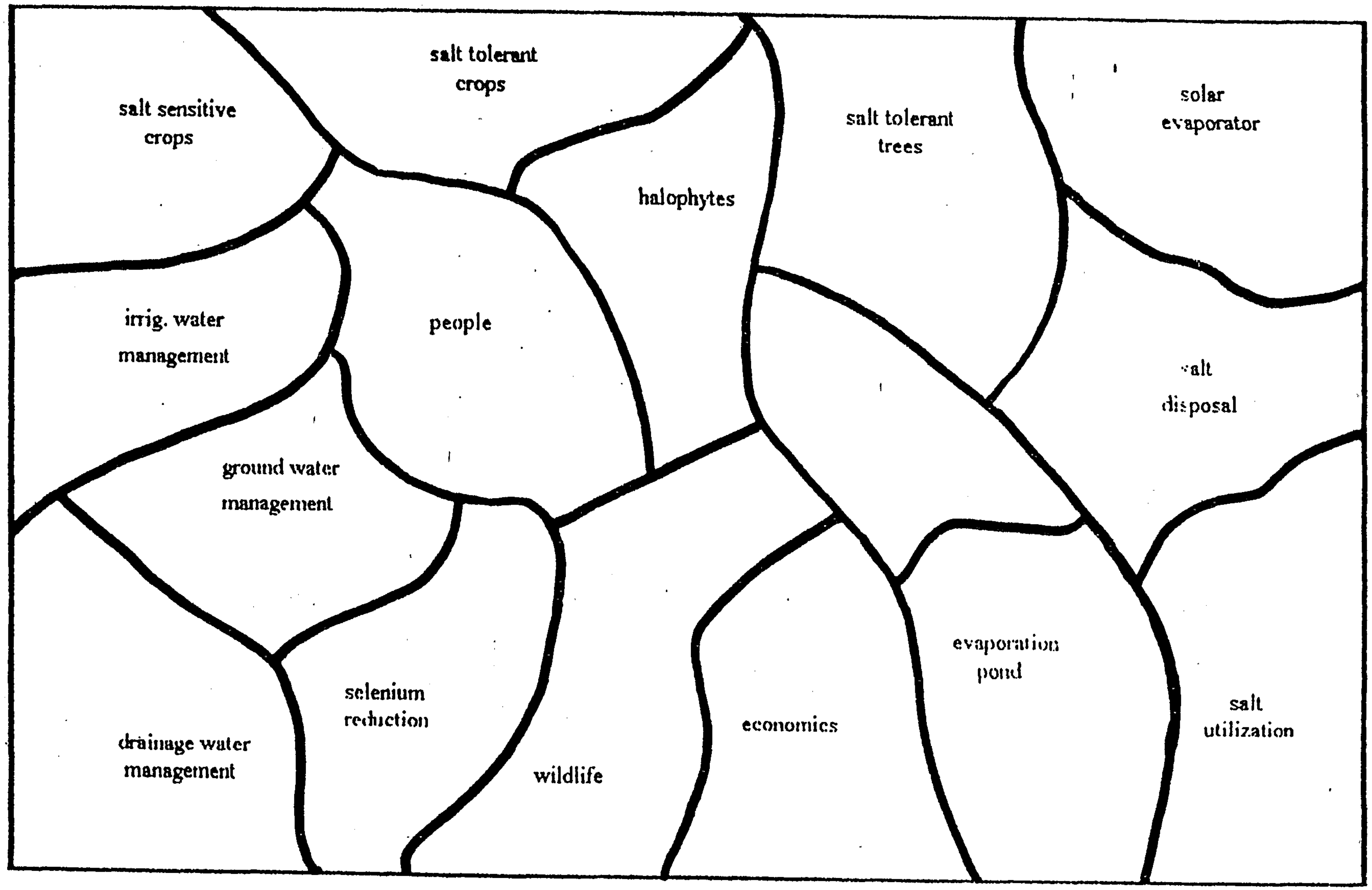

salt sensitive crops
salt tolerant crops
salt tolerant trees
solar evaporator
halophytes
irrig. water management
people
salt disposal
ground water management
drainage water management
selenium reduction
wildlife
economics
evaporation pond
salt utilization

Figure 3.